ARIZONA biodesign INSTITUTE at Arizona State University

http://www.azbio.org/

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Vision

The Arizona Biodesign Institute (AzBio) will establish a benchmark for excellence in use-inspired, collaborative research focused on the understanding of biological systems. The institute will be a multidisciplinary catalyst for the discovery and innovation required to design the critical biotechnological solutions of the 21st Century.

Mission

Scientists, engineers and clinicians partnering to improve human health, agriculture, environmental sustainability and global security. *One institute, many partners, unlimited possibilities.*

Overview

Researchers at the Arizona Biodesign Institute at Arizona State University are successfully advancing science by replicating what is already found in nature.

They learn nature's design rules and apply them in the development of new therapies, new vaccines, new rehabilitation procedures and new diagnostic devices that will transform human health care and enhance quality of life. They are pursuing discovery at the convergence of three "transcendent" technologies – biotechnology, nanotechnology and information technology. These technologies are expected to drive many new and diverse discoveries that will lead to the creation of new industries. What separates Arizona Biodesign Institute (AzBio) from many other research institutes dedicated to pioneering interdisciplinary research is that AzBio is uniquely collaborative. Talented researchers, clinicians and scientists from various academic, research and medical specialties have been selected to represent AzBio because of their willingness to dedicate their expertise to broad-based, team oriented, problem solving across disciplines and areas of specialization.

In April 2003, Arizona State University broke ground on the first of what will become a five-building complex dedicated to research and collaborative partnerships in biotechnology, nanotechnology and information technology. The Institute building will comprise 750,000 sq. ft. of advanced research space, with the first 'phase' of 170,000 sq. ft. scheduled for occupancy in Fall of 2004. Future plans include three additional modules to be completed from 2005 to 2007. ASU through AzBio will make the investments necessary to build on a multidisciplinary array of collaborative research programs that produce the new knowledge and inventions leading to ongoing opportunities for business development. Benefits will come immediately, and they include providing Greater Phoenix with the scientific talent we need to create high-quality economic opportunities for our citizens, new products and tools that provide people with a higher quality of life, and enhanced science education at all levels. A major recruitment campaign has begun with the goal to create 15-20 new centers with space allocations of c. 20-35,000 sq. ft./center.

Together with a broad range of academic, scientific, industrial and clinical partners, AzBio will produce use-inspired knowledge in biosciences, materials science, engineering and computing with a high potential for both economic success and social transformation.

Strategic Goals

ASU is committed to pursuing an investment strategy for AzBio that focuses on the intellectual capital of its people, exceptional facilities and seed funding for programs with a high potential return. The following near-term strategic goals illustrate the range of investments being made by ASU to create an academic/industrial partnership that ranks among the most productive in the nation.

Goal 1:
Build the first phase of a new state-of-the-art bioscience research facility at ASU by the fall of 2004. ASU has committed capital funds to build the first two phases of the new AzBio research complex. Phase I is a $69 million, 170,000 sq ft building on 4 levels designed to encourage collaboration and to house the highly sensitive instruments used for advanced research at the nano-scale. Phase II, of similar design, but including animal care facilities, will be complete in the Fall of 2005. ASU is actively seeking research partners who are interested in co-locating laboratory facilities in the new complex.

Goal 2:
Double the research capacity of AzBio in five years. ASU has already established a core group of highly qualified senior faculty to lead multidisciplinary research programs and to set the future direction of the research enterprise. Achieving the strategic goals of the Institute, however, requires a large number of talented new faculty and staff.

Goal 3:
Increase funding from all sectors to the AzBio research centers by 20 percent annually.
ASU is committed to leveraging Prop 301 funding by aggressively growing revenues from other sources, including:

- Research funding from government agencies and private foundations
- Income from corporate grants and contracts for both research and technology ventures
- Contributed gifts to establish the faculty chairs, professorships, postdoctoral stipends and graduate fellowships needed for high-level recruiting and retention
- Self-funding from technology enterprises

Goal 4:
Increase the formation of new academic/industrial partnerships by 20 percent annually.
ASU already enjoys high rankings in the transfer of research to the marketplace:

- 7th in the nation -- number of U.S. patent applications filed per $1 million spent on research
- 7th in the nation -- number of start-up companies formed per $10 million spent on research
- 10th in the nation -- number of inventions disclosed per $1 million spent on research

The objective is to maintain high rankings, accelerating technology commercialization, while also significantly increasing ASU’s funding base for research.

Research and Technology Development

Research in AzBio will focus on the following four research areas that offer the prospect of high impact industrial and clinical applications. They are: (1) systems biology, (2) biomimetic materials and smart devices, (3) sensors, sensor networks and imaging technology and (4) neural interface engineering and brain machine interactions. The aforementioned areas reflect the convergence of three dynamic technology streams -- biotechnology, nanotechnology and information technology.

Systems Biology
Identification and regulation of biological pathways and networks; evolutionary network design; characterization of novel biomarkers for disease diagnostics and sensors; detection of new targets for drug discovery; population genetics; gene environment interactions in disease mechanisms and implications for drug efficacy and safety.

Biomimetic Materials and Smart Devices
Structural biology; protein engineering and directed evolution methods; epitope design for vaccines; supramolecular chemistry; scaffolds for drug delivery; implants and biofeedback controlled devices; miniaturization engineering.

Sensors, Sensor Networks and Imaging Technology
Single molecule detection; molecular interactions; photobiology; fast reaction kinetics; bioinspired optical switches; low energy demand devices and power systems; meso-nanoscale directed molecular assembly and interfacial physics/chemistry; on-body/in-body sensors; sensor arrays and network architectures; real-time dynamic monitoring of cells and subcellular processes in situ.

Neural Interface Engineering and Brain-Machine Interactions
Neurobiology and mapping of sensory, cognitive and motor functions; computational models of neural architecture; neuromorphic engineering; rehabilitation engineering; brain-machine interactions; brain-actuated device control.

Leadership and Excellence

Structured as a high-performance academic/industrial partnership, AzBio is guided by the expertise and knowledge of Dr. George Poste. Formerly CEO of Health Technology Networks, Poste brings to ASU more than 25 years experience as a leader in the successful development of new technologies. His background includes serving as Chief Science and Technology Officer for SmithKline Beecham Corp. where he was associated with the successful registration of 29 drugs, diagnostics and vaccines. He is a Distinguished Fellow of the Hoover Institution at Stanford University and a member of the Department of Defense Science Board.

Research Centers

Applied NanoBioscience **Frederic Zenhausern, Director**

Goal: To apply advances in nanoscience, molecular biology and genomics to a new generation of enabling biological tools based on nano- and micro-scale technologies in order to better understand disease at the molecular level.

Relevance: The focus on applications will provide a critical link between basic nano/biosciences and engineering research, improving the monitoring of health and the treatment of many diseases.

Opportunities: The combination of microfabrication and directed molecular assembly provides a broad range of commercial applications in the design of novel sensors for use in medicine and multiple industries, delivery systems for drugs and vaccines, and as control devices for clinical and biological reactions in diverse industrial settings.

ASU-Army Flexible Display Initiative **Greg Raupp, Director**

Goal: To develop a flexible, low-power computer displays for battlefield maps that can be continually refreshed with new data and carried into field.

Relevance: Device creation that revolutionizes combat strategy by integrating displays with wireless communications technology linked to central field command and control, enabling continual updating of information vital to a successful operation. These real-time displays will provide improved operational communications by supplying information on troop and enemy positions and movements, weather and environmental conditions, and other important variables providing dynamic field intelligence.

Opportunities: Select technologies will be integrated into working prototypes and demonstrators for controlled field testing by the Army and partner companies. Learning gained through the prototyping activities will feed back into the research program to drive further advances in display size, capability and performance.

In addition to military uses, flexible display technology promises to provide a boost to U.S. display companies by helping to create many significant future commercial applications and strengthening the overall domestic display technology market.

BioOptical Nanotechnology **Neal Woodbury, Director**

Goal: To use the tools and lessons of Photochemistry and Photobiology to integrate (bio)molecular sciences with materials engineering and solid state electronics resulting in the development of molecular devices and nanoscale hybrid electronics. Expected applications of this technology include biosensors, implants, pharmaceuticals, novel biomaterials and nanoscale power sources with application in the areas of biomedicine, environmental remediation/monitoring, threat detection and agriculture.

Relevance: Biology provides us with myriad examples of molecular and nanoscale devices that are extremely specific in their functions and tightly controlled. This includes molecular machines that read and write entire genomes of DNA without error, agile sensing and remediation systems that not only detect foreign agents in the body but initiate a series of responses to remove the threat, and solar energy converters that operate at near 100% quantum efficiency.

Opportunities: Harnessing these devices, or mimetic versions of them, and interfacing them with the processing power and speed of modern day electronics promises to provide us with a whole new tool kit for combating disease, monitoring and remediating environmental change, and rapidly detecting and responding to chemical and biological threats.

Evolutionary Functional Genomics — Sudhir Kumar, Director

Goal: To understand how genes, gene families and genomes of model organisms change over time and to elucidate the gene interaction networks responsible for development of a single fertilized egg cell into a complex adult animal with trillions of cells.

Relevance: Genome sequencing and functional genomic data are growing exponentially and posing tremendous computing challenges. Finding solutions will influence progress in both health-related research and information technology.

Opportunities: The dramatic growth in the scale and complexity of biological information will drive market demands for new informatics tools for data annotation, mining and visualization to optimize information retrieval and productive utilization in diverse information sciences industrial applications.

Center for Infectious Diseases and Vaccinology — Charles Arntzen, Director

Goal: To design vaccines and protein therapeutics to combat infectious diseases - including newly emerging pathogens and potential biowarfare agents; to devise and evaluate novel biomanufacturing systems for cost effective production of the vaccines and therapeutics - and to develop and implement new strategies for translation of this research into health benefits for the developing world.

Relevance: The emergence of new and rare diseases and the rising cost of vaccines is of great concern to the global health community. Costs limit the availability of vaccines to the poor and to developing countries.

Opportunities: Finding ways to 1) produce pharmaceutical proteins and vaccines economically, 2) manufacture medicines to fight major diseases that are accessible to underdeveloped markets, and 3) produce pharmaceuticals and diagnostics in large volumes will provide the intellectual property needed for commercial development.

Neural Interface Engineering — Jiping He, Director

Goal: To develop novel approaches and technologies to investigate, monitor and rehabilitate motor function disorders due to central nervous system disease/injury through integrating nano/micro technology, neuroscience, information and system sciences, and advanced materials and rehabilitation engineering.

Relevance: Brain/spinal cord injuries, stroke and Parkinson disease cause loss of motor and cognitive functions and create financial and emotional burdens to society. By applying advanced nano/MEMS technology to develop versatile and robust neural interfaces we can reliably obtain control signals from still intact brain areas to control neuroprosthetic devices so that paralyzed people can regain motor functions and communicate in their environments for more productive and independent life.

Opportunities: Research results will spur new technologies and industrial development in biomaterials, nano/MEMS and microfabrication technology, neural interface, technology and clinical rehabilitation addressing the more than 250,000 Americans in need of brain/spinal cord injury rehabilitation. Additional developments in the area of neural interface technology will help prevent and rehabilitate stroke victims while an array of devices will help support a market that is estimated to be $1.82 billion by 2006.

Protein and Peptide Therapeutics — Colleen Brophy, Director

Goal: To identify, characterize, and optimize biologically active motifs as pharmaceuticals. The basic premise of the center is that molecules are engineered to contain a “transduction domain” (which allows the molecule to cross the cell membrane) and a “biomimetic domain” (which mimics the effect of an activated intracellular protein). This technology represents a novel approach in that cellular receptors and intracellular signaling cascades are bypassed and the product functions at the level of the intracellular target protein. This technology has the potential to generate the first “proteomic” based products developed for therapeutic applications.

Relevance: The program will generate protein based pharmaceuticals that are clinically applicable for targeted disease, cancer and wound healing. These disease processes affect broad segments of the population and rank among the top causes of mortality.

Opportunities: The primary expectation of this program is to develop therapeutics which will initiate start-up biotechnology companies. Biotechnology start-ups will attract partnerships and licensing opportunities with major pharmaceuticals.

Rehabilitation Neuroscience and Rehabilitation Engineering — James Abbas and Ranu Jung, Directors

Goal: To improve the quality of life of individuals with disabilities by designing and developing technologies to counter the effects of neurological disorders. Specifically, the center is designing techniques for enhanced therapeutic practice, investigating the effects of neurotrauma, and developing devices for improved health, fitness, and assistance with daily activities at home or in the workplace. The scope of research activities includes the design and development of algorithms and devices to interact with the nervous system, the evaluation of technology in whole animal and human subject trials, and the transfer of these technologies to biomedical industry and clinical practice. This research program uses a multi-faceted approach to address the impact of disability at several different levels.

Relevance: In the US and around the world, neurological disability often results in decreased quality of life due to medical complications, poor general health and physical fitness, reduced independence, and limited employment options. The economic impact of neurological disability on our society includes the costs of health care and personal assistance as well as the high cost of lost or reduced economic productivity.

Opportunities: The rapid growth in our understanding of the nervous system and the profound advances in electronic technology have opened up a wide variety of opportunities for interacting with the nervous system to offer clinical solutions to people with neurological disorders. More than 15 percent of the U.S. population report limitations in activity due to disabilities. Worldwide, the medical device and supply industry is growing rapidly, with Latin America and Asia among the fastest growing regions. Additionally, the aging of our society is fueling the neurotechnology products market. Biomedical devices are increasingly attractive to industry because they require less time and investment than traditional drug development.

Single Molecule Biophysics **Stuart Lindsay, Director**

Goal: To understand some of the physical processes on which life is based using the simplest model systems, either a single molecule or a small number of interacting molecules.

Relevance: The program has implications for both basic biology and for biotechnology. Understanding gene regulation, molecular signaling and molecular transport in cells may lead to cures for disease. The experimental techniques developed may lead to improved biosensors and new technologies for sequencing DNA, for example.

Opportunities: Single molecule methods will impact many areas of chemistry, biology, engineering and applied science and will result in new intellectual property with broad applicability in medicine, environment and electronics.

New Affiliations and Linkages

To achieve the strategic goals of the Arizona Biodesign Institute, ASU is committed to aggressively pursuing opportunities to collaborate with a full range of partners:

- Government agencies
- Private foundations
- Corporations
- Individual philanthropists

Business and science are natural partners and the collaboration is most productive when partners work together in an environment that encourages and stimulates partnerships.